

1 TITLE OF THE INVENTION

2 VEHICLE DRIVE ASSIST SYSTEM

3

4 BACKGROUND OF THE INVENTION

5 1. Field of the invention

6 The present invention relates to a vehicle drive assist
7 system and more particularly to a vehicle drive assist system
8 capable of detecting an oncoming vehicle which is difficult to
9 be recognized at intersections based on frontal information
10 obtained from a stereoscopic camera and the like.

11 2. Discussion about prior arts

12 When a vehicle make a right turn at intersections in
13 the "keep to the left" traffic system, in case where there are
14 oncoming vehicles waiting for turning right on oncoming lanes,
15 it is difficult for a driver to confirm oncoming vehicles
16 traveling straight. Under such situations, the driver must put
17 miscellaneous information such as oncoming vehicles, pedestrians
18 walking across a road ahead and the like in order and therefore
19 he or she is forced to bear lots of burdens.

20 In order to reduce such burdens of the driver, Japanese
21 Patent Application Laid-open No. Toku-Kai-Hei 9-282592 discloses
22 a technique in which a collision of a vehicle turning right with
23 an oncoming vehicle traveling straight in intersections is
24 prevented by detecting the oncoming vehicle with an obstacle
25 sensor installed in intersections and warning a driver.

1 However, the obstacle sensor and the warning system
2 must be installed in every intersection and a huge amount of money
3 is needed.

4 Further, Japanese Patent Application Laid-open No.
5 Toku-Kai 2001-101592 discloses a technique wherein a vehicle
6 itself has an ability to detect oncoming vehicles at an early
7 stage using a fish-eye lens installed in a bumper of the vehicle.

8 However, this technique has such problems that stains,
9 raindrops and the like sticking to the lens hinder accurate imaging
10 and also images taken through the fish-eye lens require
11 complicated correction processing.

12 13 SUMMARY OF THE INVENTION

14 It is an object of the present invention to provide
15 a vehicle drive assist system requiring no special infrastructure
16 capable of accurately detecting an oncoming vehicle traveling
17 straight in intersections with a simple structure.

18 In order to attain the object, a vehicle drive assist
19 system according to the present invention includes frontal
20 circumstances recognizing means for recognizing a solid object
21 in front of an own vehicle based on images taken by imaging means,
22 oncoming lane crossing intension detecting means for detecting
23 an intension of the own vehicle to cross an oncoming lane, oncoming
24 waiting vehicle detecting means for detecting an oncoming vehicle
25 waiting in front of the own vehicle on the oncoming lane, oncoming

1 straight vehicle detecting area establishing means for
2 establishing a detecting area on in the vicinity of the oncoming
3 vehicle waiting and oncoming straight vehicle detecting means
4 for detecting an oncoming vehicle traveling straight in the
5 detecting area.

6 7 BRIEF DESCRIPTION OF THE DRAWINGS

8 Fig. 1 is a schematic view showing a vehicle
9 incorporating a vehicle drive assist system according to the
10 present invention;

11 Fig. 2 is a flowchart of a routine for a vehicle drive
12 assist control;

13 Fig. 3 is a flowchart of an oncoming straight vehicle
14 detection routine;

15 Fig. 4 is an explanatory diagram showing a situation
16 of a vehicle making a right turn in an intersection; and

17 Fig. 5 is an explanatory diagram showing a frontal image
18 viewed from an own vehicle.

19 20 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

21 Referring now to Fig. 1, reference numeral 1 denotes
22 an own vehicle on which a vehicle drive assist system 2 for
23 detecting a presence of a vehicle coming on straight at crossroads
24 and for warning a driver, is mounted.

25 The vehicle drive assist system 2 has a pair (left and

right) of CCD cameras 3 using a solid-state image component such as Charge Coupled Device and the left and right cameras 3 are transversely mounted on a front ceiling of a passenger compartment at a specified interval of distance, respectively. The respective cameras take stereoscopic images of an outside object from different view points.

Further, the vehicle 1 has a vehicle speed sensor 4 for detecting a vehicle speed V , a turn signal lever 5 operated by a driver when the vehicle 1 makes a turn and the like. These detected signals indicative of the vehicle speed V , indicative of left or right turns and frontal images taken by the pair of CCD cameras 3 of the own vehicle 1 are inputted to a control apparatus 6.

Further, the control apparatus 6 inputs the own vehicle speed V , the operating signal of the turn signal switch 5 and the frontal images of the own vehicle 1 and warns the driver by operating a warning lamp 8 and a warning buzzer 9 provided in a combination meter 7 in case where an oncoming vehicle traveling straight exists when the own vehicle 1 is going to make a right turn.

The control apparatus 6 is constituted by a multi-micro processor having an image processor. The processing of images sent from the CCD cameras 3 is performed as follows. First, with respect to a pair of stereoscopic images taken by the stereoscopic CCD camera 3, distance information over the entire image is obtained

1 from the deviation amount between corresponding positions
2 according to the principle of trianguration and distance images
3 representing three-dimensional distance distribution are formed
4 based on that distance information. Then, lane marker data, side
5 wall data such as guardrails, curbs and side walls arranged along
6 the road and solid object data such as vehicles and the like,
7 are extracted through the well known grouping process by
8 comparing the distance images with the three-dimensional road
9 profile data, side wall data, solid object data and the like stored
10 beforehand.

11 Thus extracted lane marker data, side wall data and
12 solid object data are denoted by individually different numbers,
13 respectively. Further, the solid object data are classified into
14 a stationary object in standstill, a forward moving objects moving
15 in the same direction as the own vehicle 1, an oncoming vehicle
16 coming against the own vehicle 1 and the like from the relationship
17 between the relative displacement of the distance from the own
18 vehicle 1 and the vehicle speed of the own vehicle 1.

19 Further, the control apparatus 6 detects a situation
20 where the own vehicle 1 is in a transfer process from driving
21 straight to turning right off the own lane and detects a presence
22 of an oncoming waiting vehicle on the oncoming lane ahead of the
23 own vehicle 1. The oncoming waiting vehicle is classified into
24 two kinds, an oncoming vehicle waiting for right turn and an
25 oncoming vehicle traveling straight but waiting for right turn

1 of the own vehicle. Further, the control apparatus 6 establishes
2 an oncoming straight vehicle detection area wherein an oncoming
3 vehicle traveling straight is detected. In case where a solid
4 object exists in an image, this detection area is established
5 in the vicinity of the right edge of the object. In case where
6 another object is detected in a detection area established in
7 the next frame of the image, it is judged whether or not there
8 is difference between distant information of the oncoming vehicle
9 waiting right turn and distance information of the new object.
10 In case where there is no different distance information, it is
11 judged that the left side (when viewed from the solid object)
12 or the right side (when viewed from the own vehicle 1) part of
13 the new solid object is detected and the new solid object is an
14 oncoming vehicle traveling straight. This judgment can eliminate
15 possibility that a vehicle coming from the right (when viewed
16 from the own vehicle 1) is erroneously recognized to be an oncoming
17 vehicle traveling straight. Further, in case where the oncoming
18 vehicle traveling straight is detected, the control apparatus
19 6 operates the warning lamp 8 and the warning buzzer 9 according
20 to a position where the oncoming vehicle traveling straight exists.
21 Further, the control apparatus 6 acts as frontal circumstance
22 recognizing means, oncoming lane crossing intension detecting
23 means, oncoming waiting vehicle detecting means, oncoming
24 straight vehicle detecting area establishing means and oncoming
25 straight vehicle detecting means and warning means.

1 The drive assist control program of the control
2 apparatus 6 will be described by referring to a flowchart of Fig.
3 2. This routine is executed every specified time. First, at a
4 step (hereinafter referred to as "S") 101, images, the own vehicle
5 speed V and the operating signal input to the control apparatus
6 6 from the CCD camera 3, the vehicle speed sensor 4 and the turn
7 signal switch 5, respectively.

8 Then, the program goes to S102 where solid objects are
9 extracted and recognized based on the images from the CCD camera
10 3.

11 Then, the program goes to S103 where an oncoming vehicle
12 traveling straight which will be described hereinafter in detail
13 is detected by an oncoming vehicle traveling straight detecting
14 routine and goes to S104. At S104, it is judged whether or not
15 the oncoming vehicle traveling straight is detected at S103.

16 In case where no oncoming vehicle traveling straight
17 is detected, the program leaves the routine and in case where
18 an oncoming vehicle traveling straight is detected, the program
19 goes to S105.

20 When an oncoming vehicle traveling straight is detected
21 and the program goes to S105, the control apparatus 6 outputs
22 an operating signal to the warning lamp 8 and the warning buzzer
23 9 according to the distance between the oncoming vehicle traveling
24 straight and the own vehicle 1 and the program leaves the routine.
25 The operating signal has a higher frequency as the distance between

the oncoming vehicle and the own vehicle becomes short and has a lower frequency as the distance becomes far. Further, the acoustic level of the warning buzzer 9 may be varied according to the distance between the oncoming vehicle and the own vehicle.

The oncoming vehicle traveling straight detecting routine will be described by referring to a flowchart shown in Fig. 3.

First, at S201, it is judged whether or not the own vehicle 1 transfers to an oncoming vehicle detecting mode. If the own vehicle 1 does not transfer to the oncoming vehicle detecting mode, the program skips to S212 where the next frame is checked, leaving the routine. The oncoming vehicle detecting mode is a condition that the vehicle speed of the own vehicle 1 is low (for example, below 15 kilometers/hour) and also the turn signal switch 5 is turned on for turning right.

If it is judged that the own vehicle transfers to the oncoming vehicle detecting mode, the program goes to S202 where it is judged whether or not a solid object exists in front of the own vehicle 1 at a short distance (for example, 4 meters to 12 meters). As a result of the judgment, if no solid object exists, the program skips to S212 where the next frame is checked, leaving the routine. Further, if a solid object exists, the program goes to S203 where it is judged whether or not the solid object is coming close to the own vehicle 1 at a low speed (for example, below 15 kilometers/hour).

1 As a result of the judgment at S203, if the solid object
2 is not coming close to the own vehicle 1 at a low speed, the program
3 skips to S212 where the next frame is checked, leaving the routine.
4 Further, if the solid object is coming close to the own vehicle
5 1 at a low speed, the program goes to S204 where it is investigated
6 whether or not the solid object has been detected successively
7 in a couple of past frames (for example, 3 frames).

8 That is, in this condition, as shown in Fig. 4, there
9 is possibility that the solid object is an oncoming vehicle waiting
10 right turn or an oncoming vehicle traveling straight but waiting
11 for the own vehicle turning right. Hereinafter, these vehicles
12 are referred to as an oncoming waiting vehicle. Such images as
13 shown in Fig. 5 are taken from the own vehicle 1. That is, it
14 is judged whether or not such images appear on successive three
15 past frames.

16 As a result of this judgment, in case where such images
17 do not appear on successive three past frames, the solid object
18 is judged to already pass or is judged to be a detection error
19 and the program skips to S212, leaving the routine.

20 On the other hand, in case where the solid object is
21 detected successively in a couple of past frames, the program
22 goes to S205 in which it is judged that the solid object is an
23 oncoming waiting vehicle. At this moment, a recognition frame
24 Wa is formed around the oncoming waiting vehicle on the image
25 and an oncoming vehicle traveling straight detecting area is

1 established in the vicinity of the right (when viewed from the
2 own vehicle 1) edge of the recognition frame Wa.

3 After that, the program goes to S206 where it is judged
4 whether or not another object always exists in that established
5 detecting area . As a result of this judgment, in case where the
6 other object always exists, this solid object is deemed to be
7 another oncoming vehicle waiting right turn behind a forefront
8 oncoming vehicle waiting right turn, an oncoming vehicle traveling
9 straight but waiting own vehicle turning right or a lateral side
10 surface of the forefront oncoming vehicle waiting right turn.
11 Then, at S207, a new oncoming vehicle traveling straight detecting
12 area (new detecting area) is established in the vicinity of the
13 right (when viewed from the own vehicle 1) edge of the other object
14 and the same process as S206 is repeated.

15 As a result of the judgment at S206, in case where no
16 solid object always exists in that detecting area, the program
17 goes to S208 where the next frame is checked. At S209, it is judged
18 whether or not a new solid object appears in the detecting area
19 of the next frame.

20 As a result of the judgment at S209, in case where a
21 new solid object appears in the detecting area of the next frame,
22 a recognition frame Wb of the new solid object is established
23 as shown in Fig. 5. The program goes to S210 where it is judged
24 whether or not only a right side (when viewed from the own vehicle
25 1) part of the new solid object is detected by judging whether

1 or not distance information different from distance information
2 to the new solid object and to the oncoming waiting vehicle,
3 respectively exists between the new solid object and the oncoming
4 waiting vehicle.

5 As a result of the judgment at S210, in case where there
6 is a part having different distance values, the program skips
7 to S212 where the next frame is checked, leaving the routine.
8 Further, in case where there is no part having different distance
9 values, it is judged at S211 that the right side part of the new
10 solid object has appeared and this solid object is an oncoming
11 vehicle traveling straight and the judgment is outputted to the
12 warning lamp 8 and the warning buzzer 9. Then, the program goes
13 to S212 where the next frame is checked, leaving the routine.

14 On the other hand, as a result of the judgment at S209,
15 in case where no new solid object is found at the detecting area
16 of the next frame, the program skips to S212 where the second
17 next frame is checked, leaving the routine.

18 According to the embodiment of the present invention,
19 an oncoming vehicle traveling straight at an intersection can
20 be detected easily and simply only by attaching the oncoming
21 vehicle traveling straight detecting program to the image process
22 using a pair of CCD cameras 3 mounted on the own vehicle 1 and
23 executing the program.

24 Further, since the pair of CCD cameras 3 is disposed
25 in the passenger compartment, there is no troubles caused by

1 stains or raindrops. Further, the oncoming vehicle traveling
2 straight can be detected at an early stage without calculating
3 the vehicle speed or the traveling direction of the oncoming
4 vehicle traveling straight.

5 In the embodiment, the vehicle drive assist control
6 system has been described under the keep to the left traffic system,
7 however, it is needless to say that the drive assist control system
8 can be applied to the "keep to the right" traffic system.

9 The entire contents of Japanese Patent Application No.
10 Tokugan 2003-113139 filed April 17, 2003, is incorporated herein
11 by reference.

12 While the present invention has been disclosed in terms
13 of the preferred embodiment in order to facilitate better
14 understanding of the invention, it should be appreciated that
15 the invention can be embodied in various ways without departing
16 from the principle of the invention. Therefore, the invention
17 should be understood to include all possible embodiments which
18 can be embodied without departing from the principle of the
19 invention set out in the appended claims.

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